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Author(s):	Booth, Steven Richard
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Issued:	2019-10-04

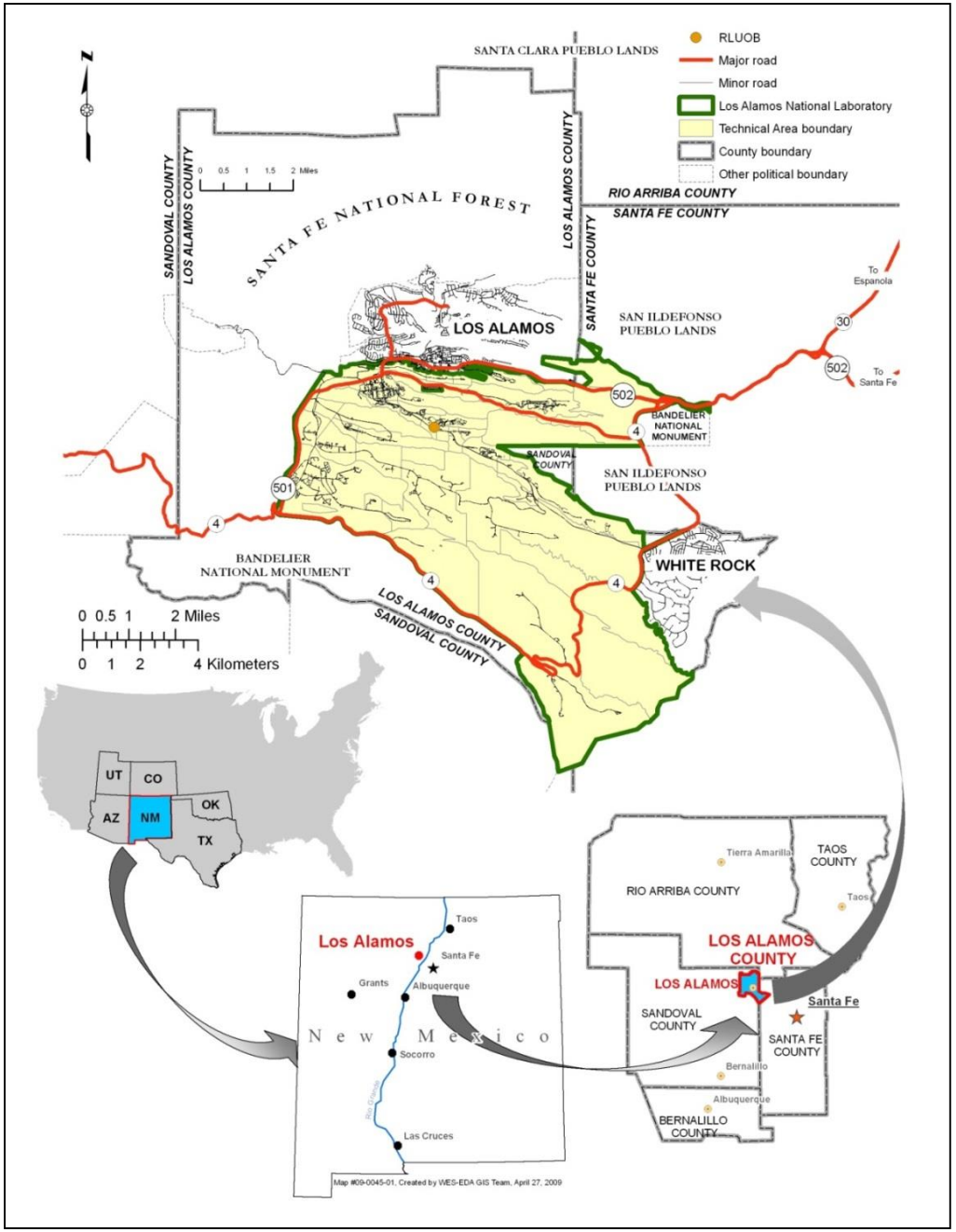
LA-UR-19-????

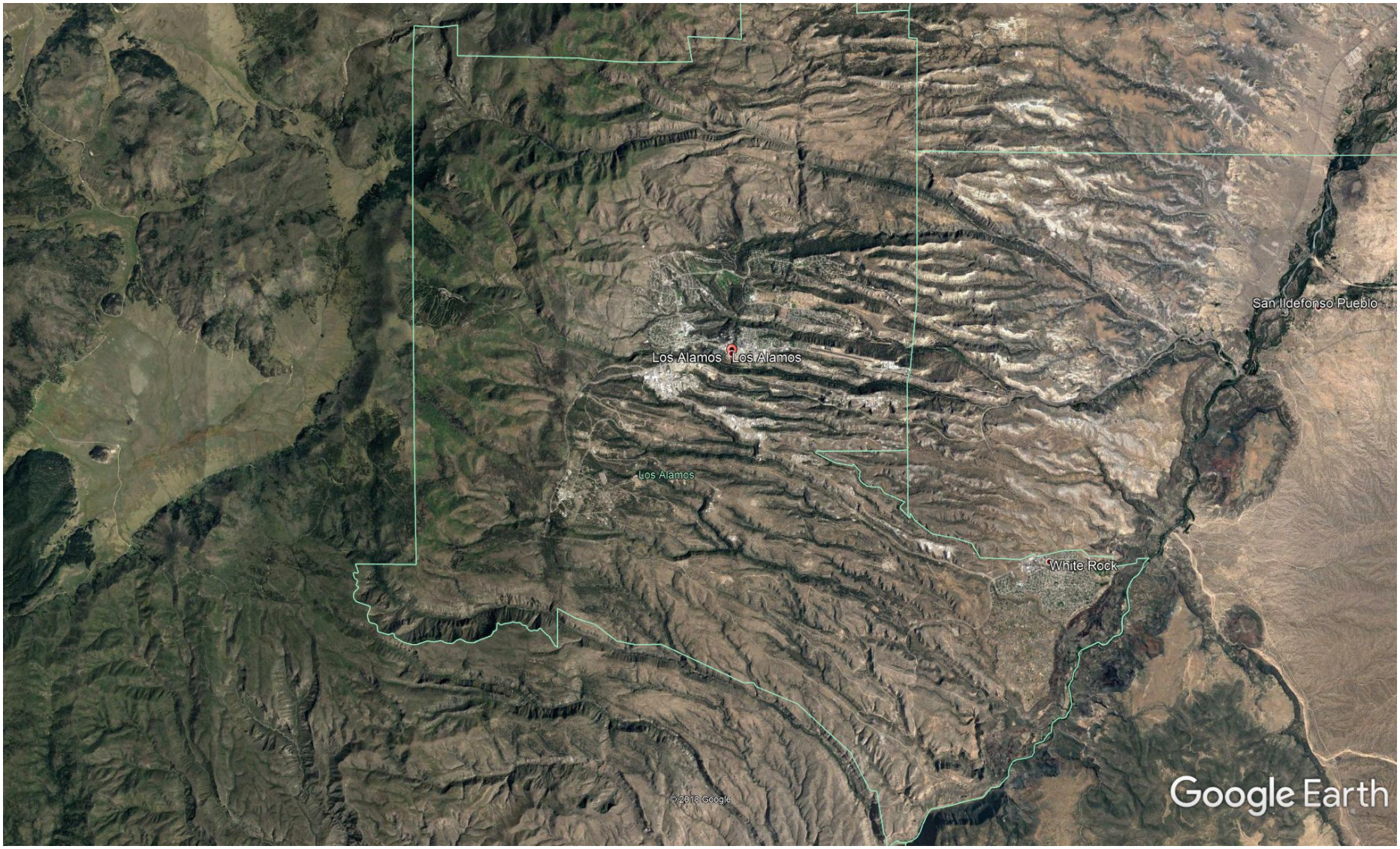
Economic Support for Los Alamos National Laboratory Management Decisions

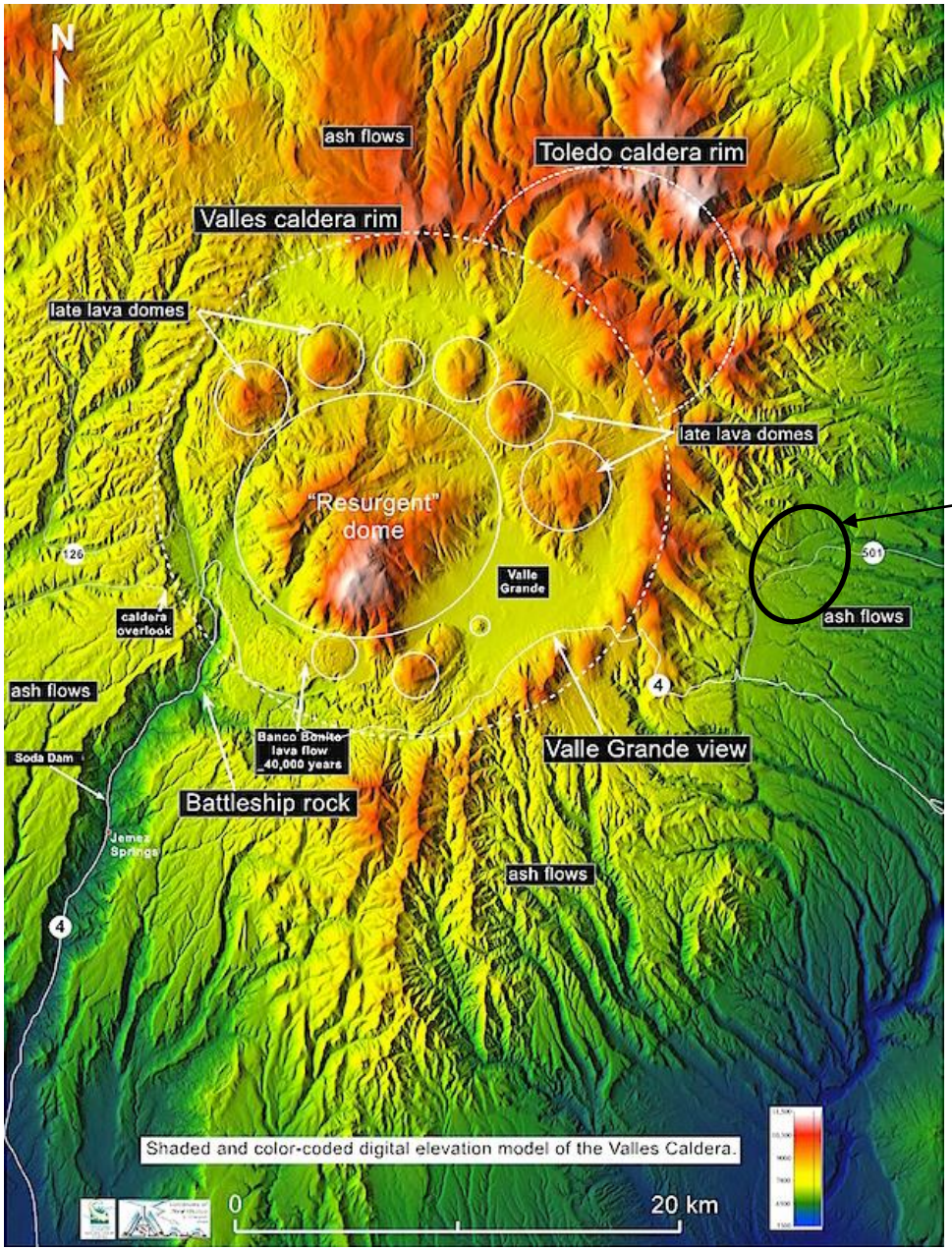
Presentation at Clemson University

Steven Booth

October 28, 2019


RLUOB
Major road
Minor road
Los Alamos National Laboratory
Technical Area boundary
County boundary
Other political boundary
SANTA CLARA PUEBLO LANDS
SANTA FE NATIONAL FOREST
SANDOVAL COUNTY
LOS ALAMOS COUNTY
RIO ARRIBA COUNTY
SANTA FE COUNTY
LOS ALAMOS
SAN ILDEFONSO PUEBLO LANDS
BANDELIER NATIONAL MONUMENT
WHITE ROCK
To Espanola
To Santa Fe
0 0.5 1 2 Miles
0 1 2 4 Kilometers
UT
CO
AZ
NM
OK
TX
Los Alamos
Taos
Santa Fe
Grants
Albuquerque
Socorro
Las Cruces
New Mexico
Rio Grande
Tierra Amarilla
TAOS COUNTY
RIO ARRIBA COUNTY
LOS ALAMOS COUNTY
SANDOVAL COUNTY
SANTA FE COUNTY
BERNALILLO COUNTY
Bernalillo
Map #09-0045-01, Created by WES-EDA GIS Team, April 27, 2009


San Ildefonso Pueblo
Los Alamos
Los Alamos
Los Alamos
White Rock
© 2018 Google
Google Earth



Los Alamos, NM

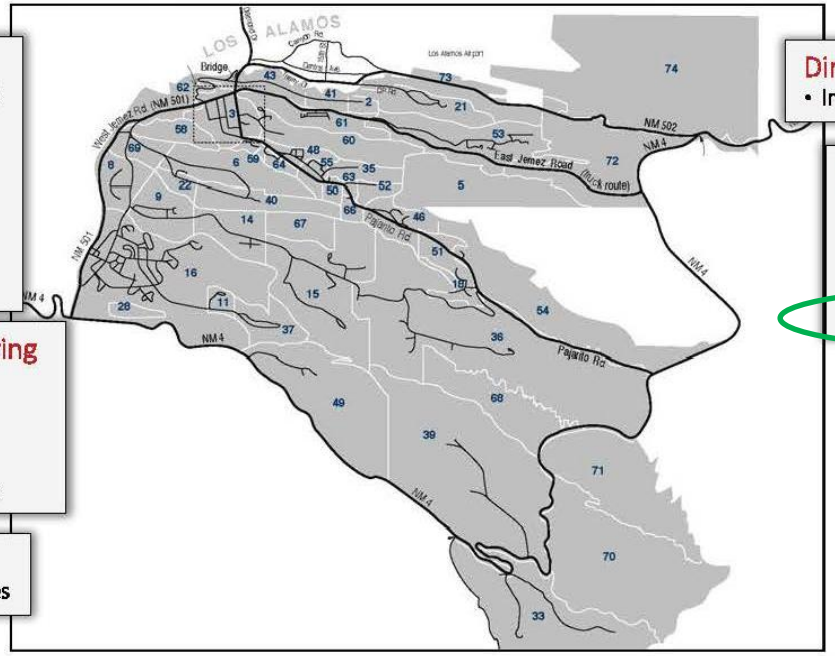
The collapse crater is 20 km in diameter.

National Infrastructure Simulation & Analysis Center (NISAC)

Weapons Programs
- Weapons Physics Design and Computation
- Weapons Engineering
- High Explosives
- Plutonium
- Tritium/GTS
- Uranium, Beryllium, Salts, Metals
- Detonators
- Component Fabrication and Assembly

Science, Technology & Engineering
- Chemistry, Earth and Life Sciences
- Accelerator Science
- Engineering Sciences
- Materials and Physical Sciences
- Theoretical and Computational Sciences

Capital Projects
- Project Management Services



Director's Office
- Institutional Management

Global Security
- Nuclear Nonproliferation
- Nuclear Counter-Proliferation
- Emerging Threats
- Intelligence Community
- National Defense and Homeland Security

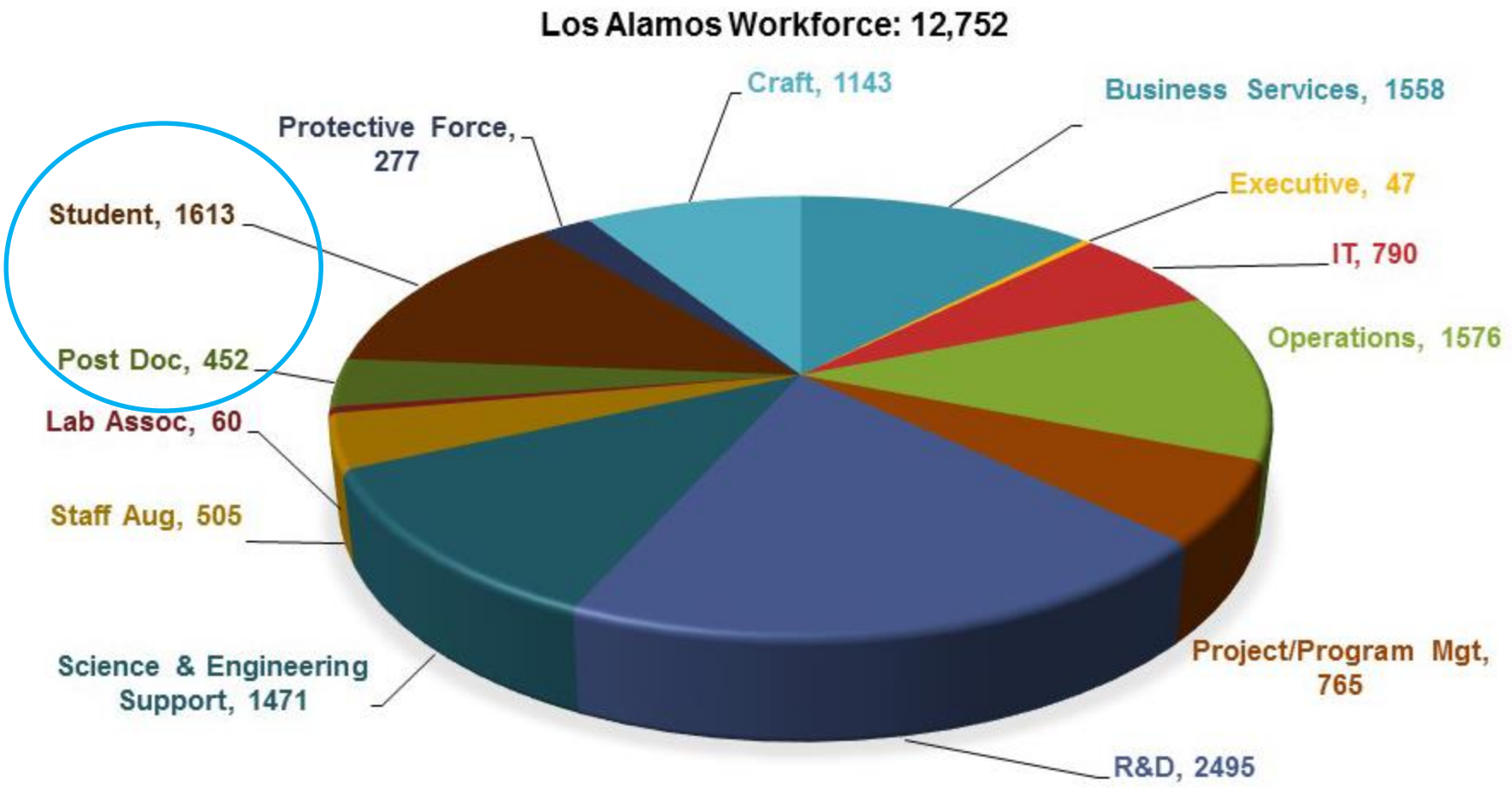
Institutional Operations
- Business Services
- Environmental, Safety, and Health
- Nuclear & High Hazard Operations
- Security and Mission Assurance

40 square miles 47 technical areas 1,280 buildings/ 9M sq ft 11 nuclear facilities 268 miles of roads

~8,400 career employees/~12,000 workers on site 2,400 R&D scientists 1,100 veterans 400 postdocs 1,880 students

$2.8B budget 4,700 projects 600 B&R codes

11 Directorates 60 Divisions


Los Alamos Workforce: 12,752
Craft, 1143
Business Services, 1558
Protective Force, 277
Executive, 47
Student, 1613
IT, 790
Operations, 1576
Post Doc, 452
Lab Assoc, 60
Staff Aug, 505
Science & Engineering Support, 1471
Project/Program Mgt, 765
R&D, 2495

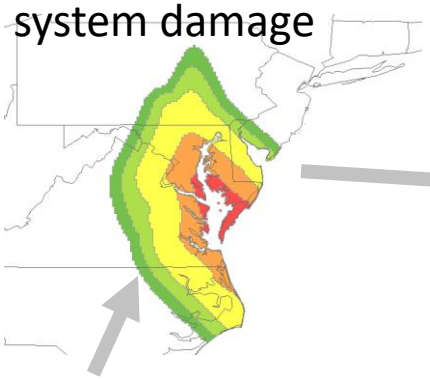
NISAC models

- Sophistication • Scale/resolution
- Computational times • Data needs

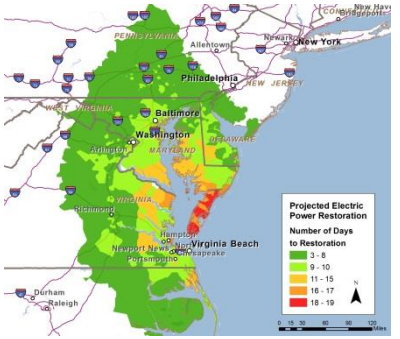
Population

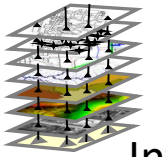
Economic activity

Electric power system damage

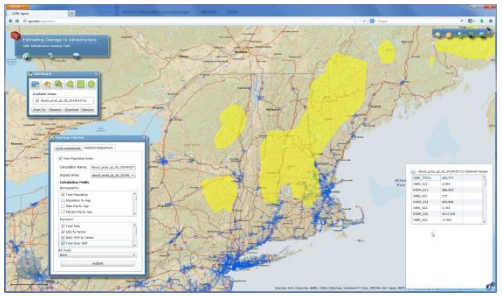


Electric power restoration

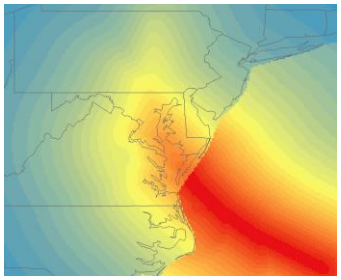




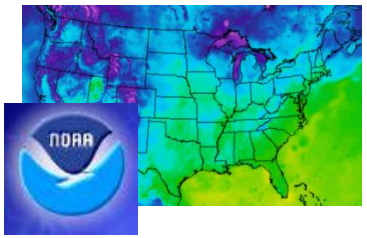
Interdependent infrastructures



Ice storm forecast

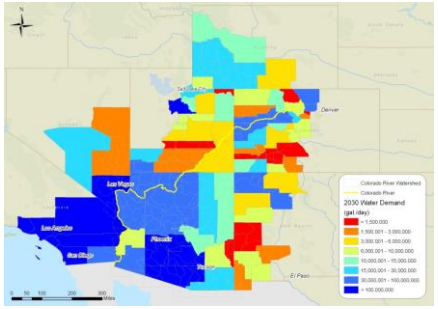


Hurricane winds

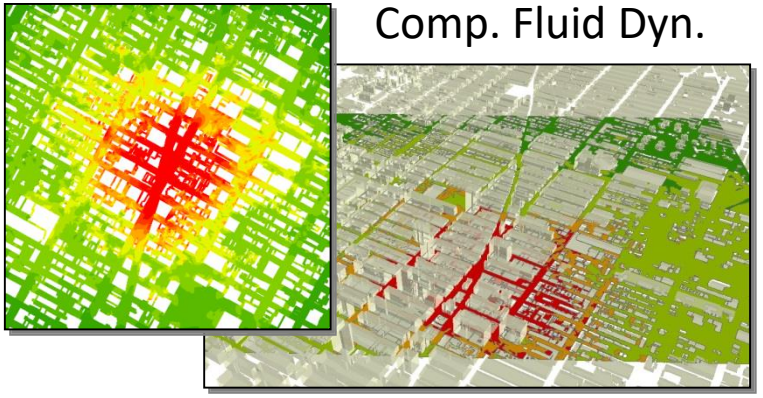


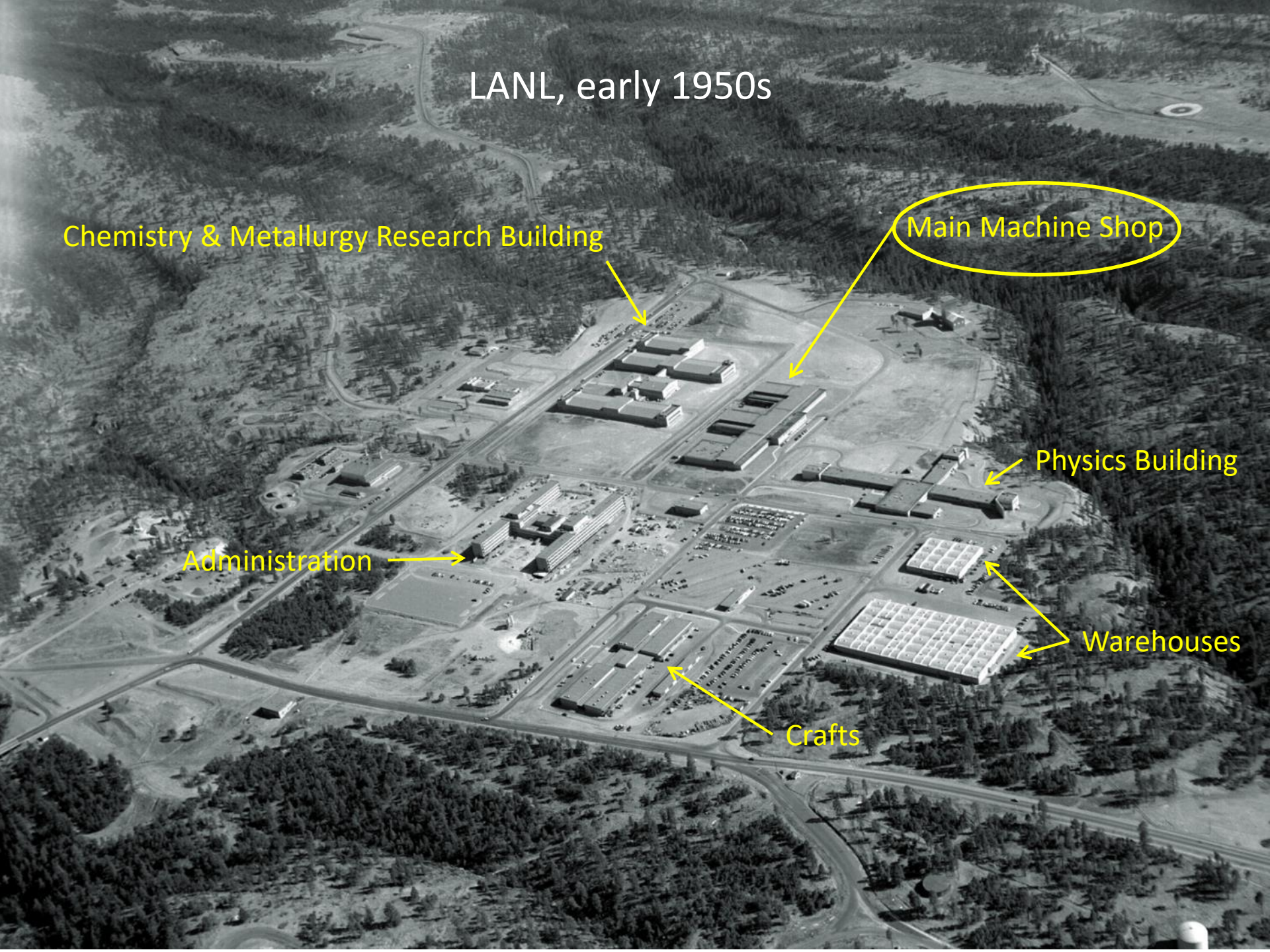
NOAA forecasts

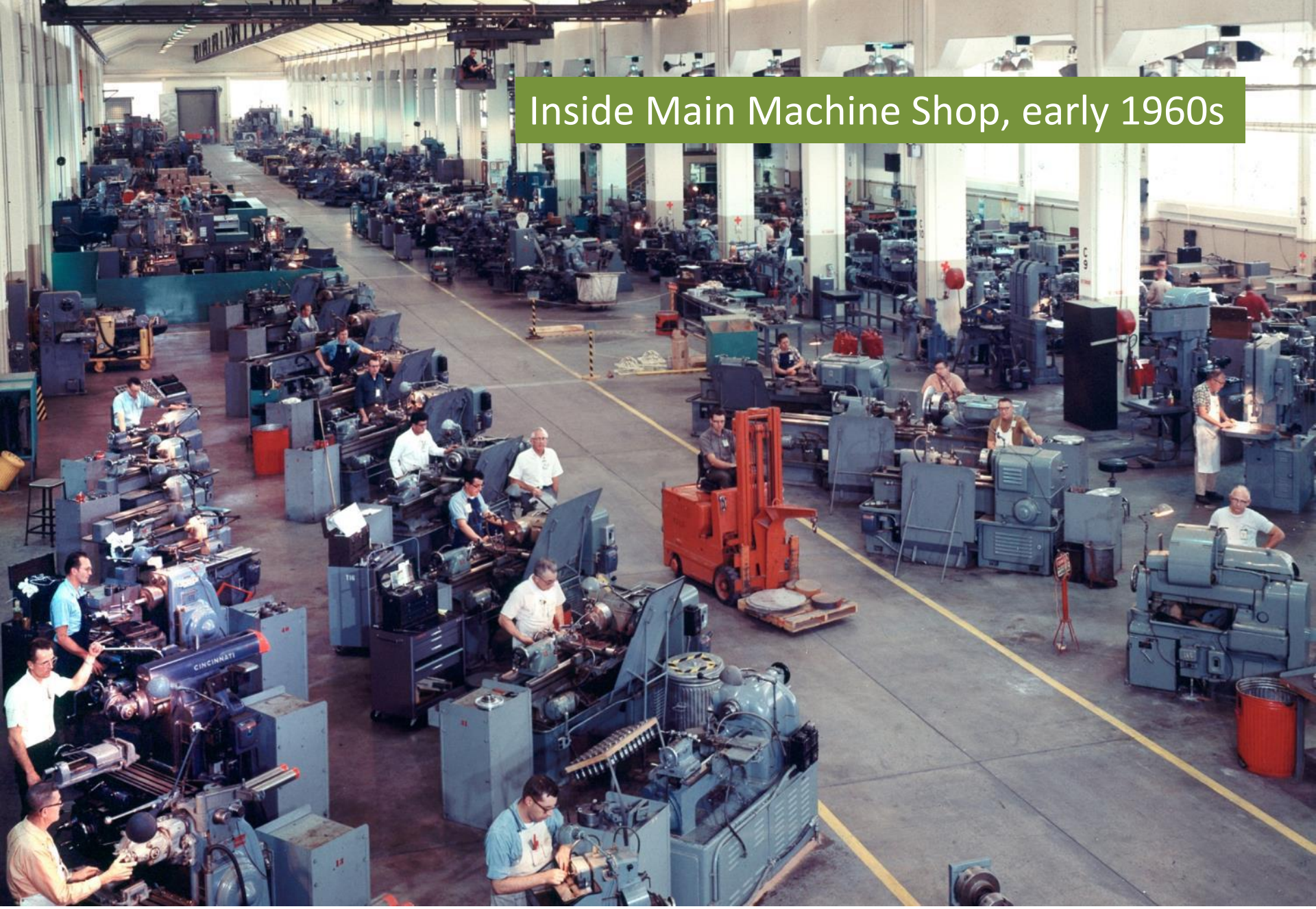
Water Demand

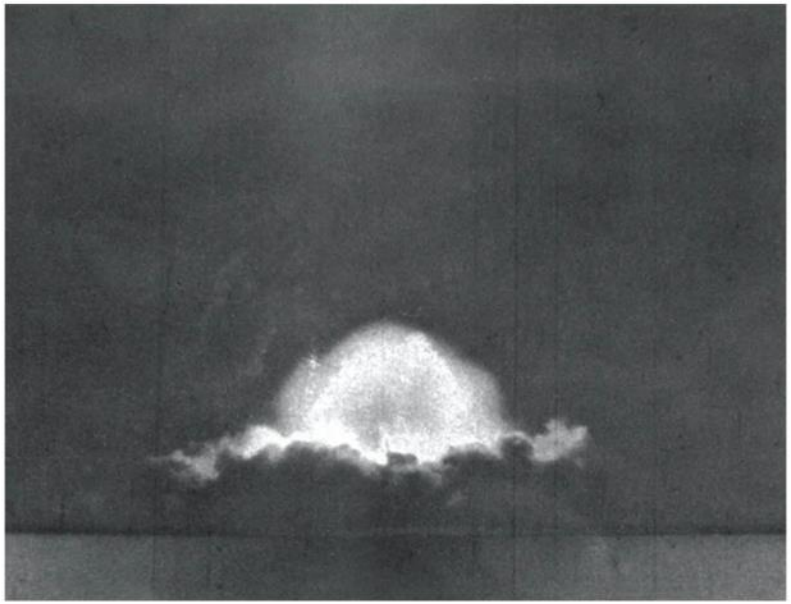


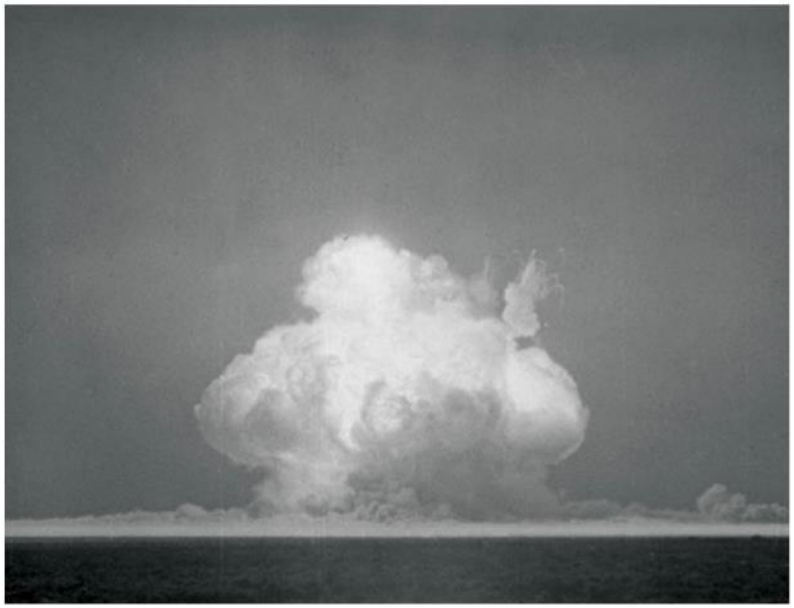
Comp. Fluid Dyn.




LANL, early 1950s
Chemistry & Metallurgy Research Building
Main Machine Shop
Physics Building
Administration
Warehouses
Crafts


Inside Main Machine Shop, early 1960s
CINCINNATI





The test director, Kenneth Bainbridge, called the explosion a "foul and awesome display" and remarked to Oppenheimer, "Now we are all sons of bitches."

Oppenheimer recalled the line from the *Bhagavad-Gita*: "Now I am become Death, the destroyer of worlds."

Trinity Device Blast, July 16, 1945

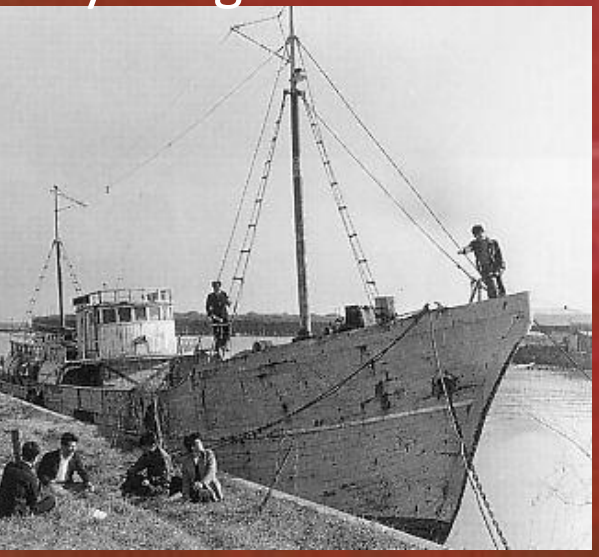
July 24, 1946, a device similar to Fat Man was detonated 90 feet below the surface of Bikini Lagoon

Greenhouse Test Series, Eniwetok Atoll in April and May of 1951

Ivy Mike conducted in the fall of 1952 at the Eniwetok Atoll Pacific Proving Ground

Castle-Bravo Test, March 1, 1954

ucky Dragon" Tuna Boat



Eniwetok Atoll, with craters from two tests

Soldiers participating in Operation Tumbler-Snapper, May 1952

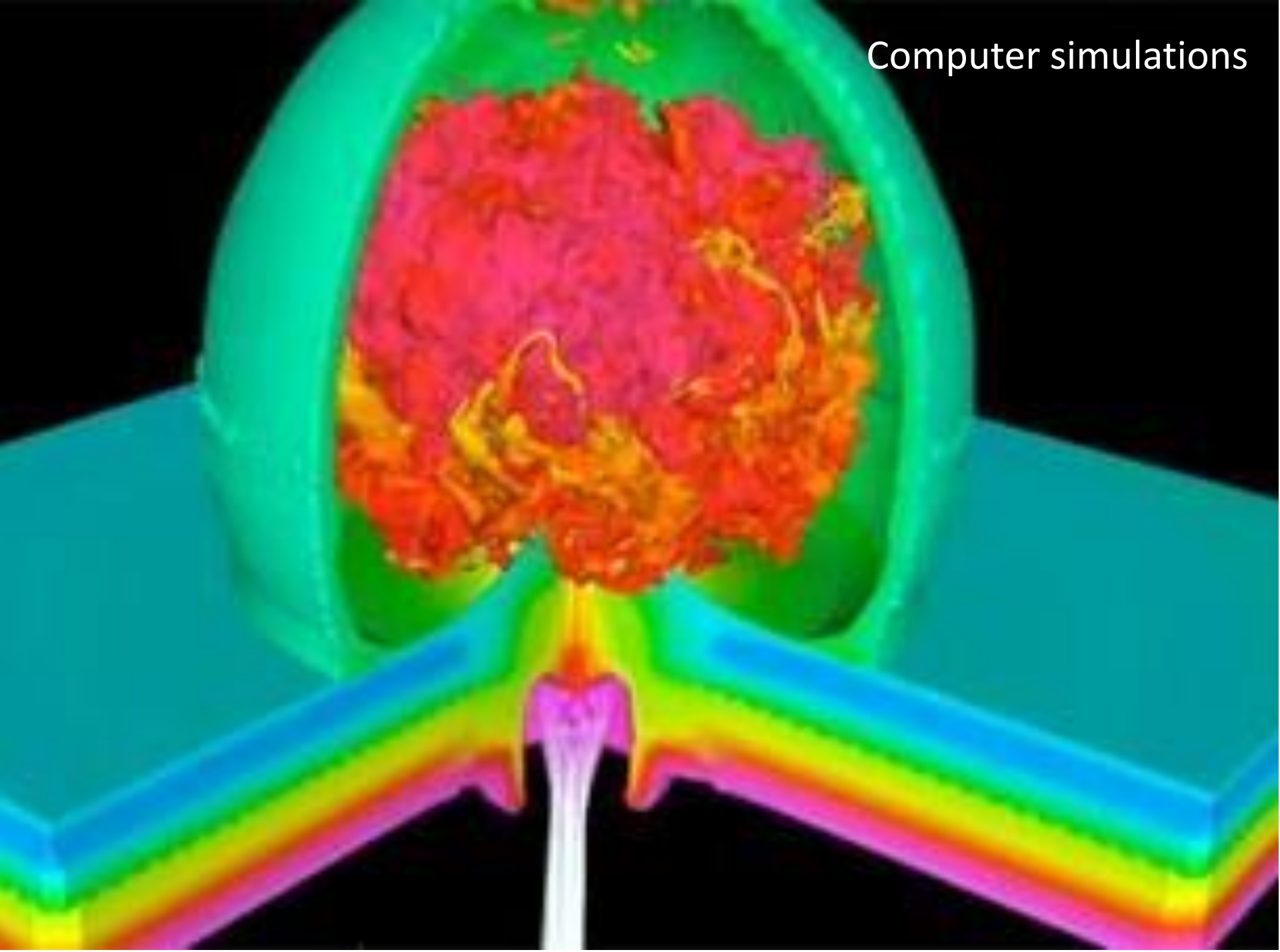
On May 25, 1953, Operation Upshot-Knothole test series at the Nevada Test Site (NTS): a 280-mm cannon fired the first and last nuclear projectile as part of the Grable test.


Setting up an underground test at
Nevada Test Site took time and
miles of cables.

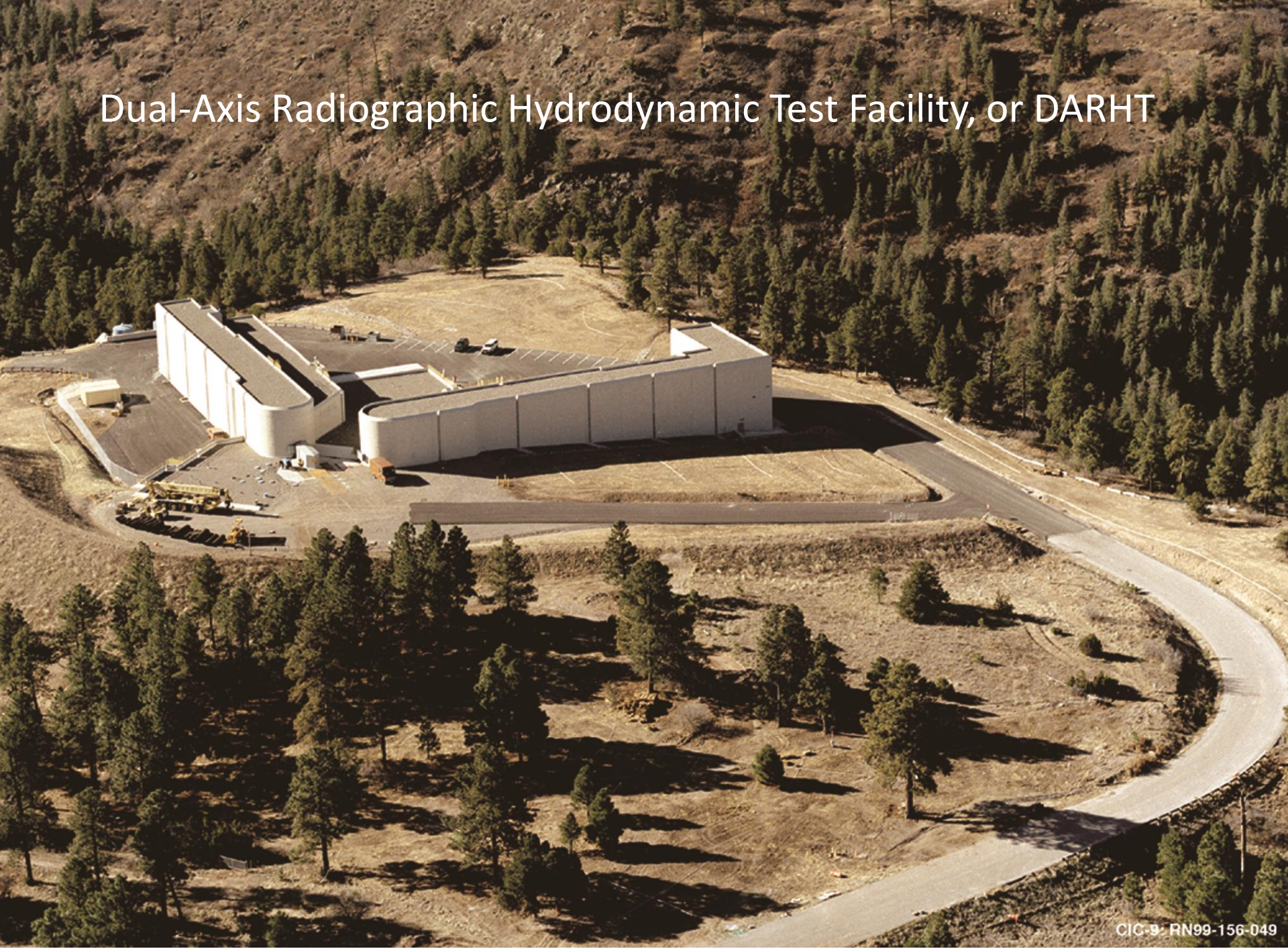
ndrel-Pliers, an underground
t in Nevada, was conducted on
gust 27, 1969.


Hundreds of test craters would eventually
pockmark the Nevada Test Site.

Last nuclear weapon test in USA:
“Divider,” September 23, 1992


Computer simulations

Dual-Axis Radiographic Hydrodynamic Test Facility, or DARHT




DARHT Containment Vessel

AET-2
Process Modeling & Analysis

LA-UR-15-23303
Approved for public release; distribution is unlimited

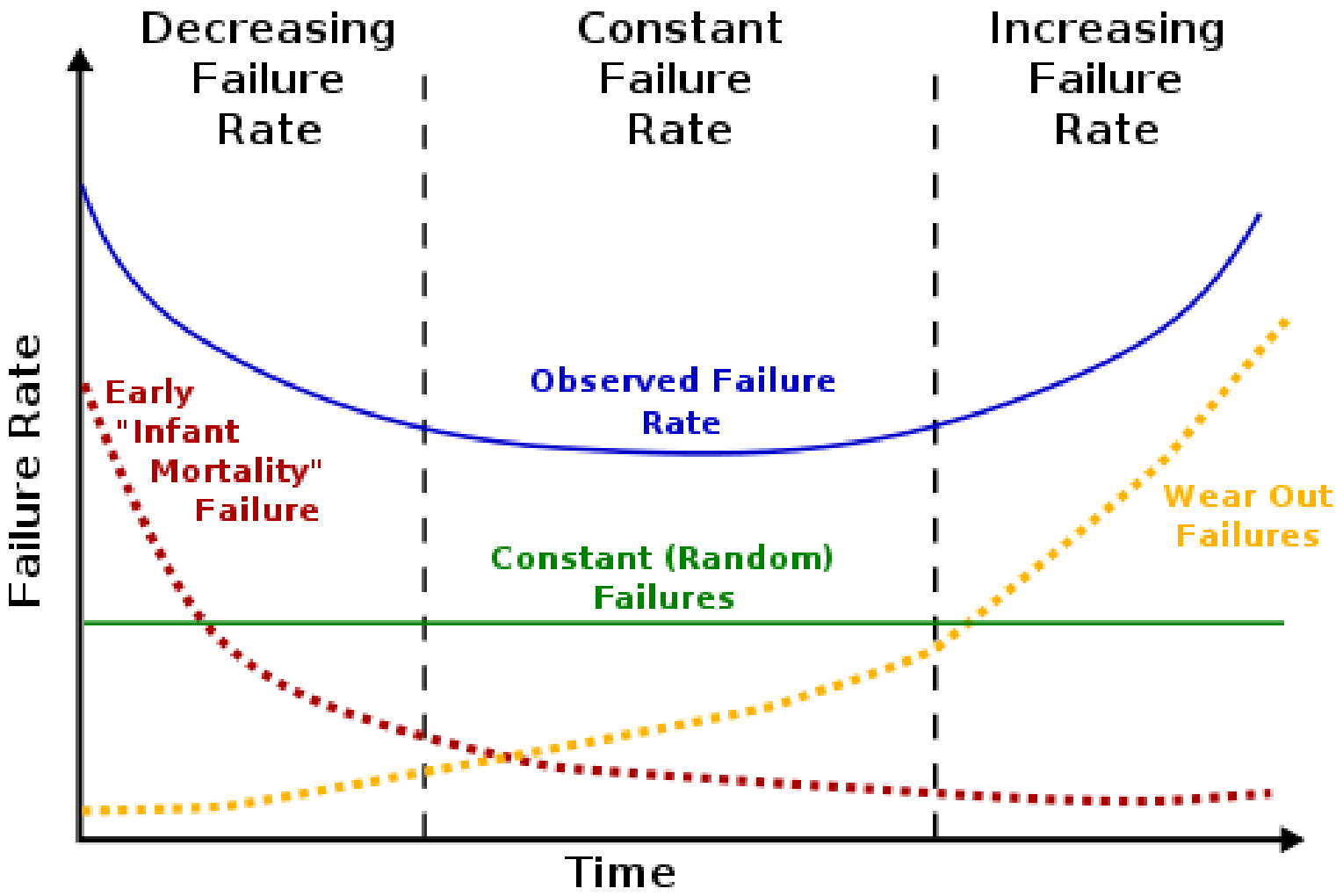
Business Case Analysis of Prototype Fabrication Division Recapitalization Plan

Steven R. Booth
Faith A. Benson
Timothy G. Dinehart

May 2015

Los Alamos
NATIONAL LABORATORY
EST. 1943

NNSA
National Nuclear Security Administration



Bathtub curve showing relatively high equipment failure during early and late ages.

Source: Wikipedia, http://upload.wikimedia.org/wikipedia/commons/thumb/7/78/Bathtub_curve.svg/500px-Bathtub_curve.svg.png

In terms of the maintenance life cycle, the new equipment scenario is at the beginning of operations and the baseline scenario is at the disposition/recapitalization decision stage.

Mazak Mill-Turn

SM-39

New (for hydros)

Replace

Old (Mazak 30Y)

Make 10 parts/year
@ 2 wks/part (new)
vs. 8 wks/part (old)

Total Net PV: $4.5M

(Keep old machines for other work)

Bldg 102

New (for hydros)

Replace

Old (Haas VF-3)

Make 10 parts/year
@ 2 wks/part (new)
vs. 16 wks/part (old)

Total Net PV: $11M

Lathes

SM-39

New

Replace

Old (remove)

Make 16 parts/year
@ 40 hrs/part (new)
vs. 80 hrs/part (old)

Total Net PV: $1.2M

Bldg 102

New

Augment*

Old (keep or replace)

Make 16 parts/year
@ 40 hrs/part (new)
vs. 100 hrs/part (old)

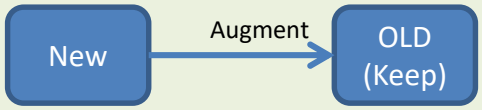
Total Net PV: $0.3M to $1.8M

*Note: One of the Ex-Cell-O T-base lathes failed the week of March 2, 2015, and the other Ex-Cell-O T-base lathe is expected to fail as well. This scenario may become a replacement.

EDM

SM-39

Bldg 102

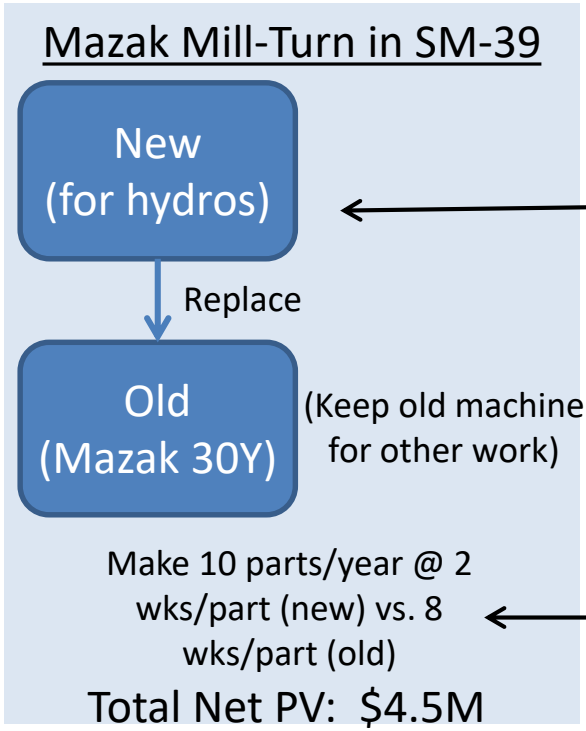


Make 56 parts/year @ 2-4 hours saved/part (demand will increase)

Total Net PV: ($0.6M)

MAZAK Integrex 30-Y in SM-39

New Mazak in SM-39



One-Time Costs

Equipment:	$550k
Procurement:	$76k
Facility Prep:	$85k
Installation:	$55k
Training:	$117k
Qualification:	$52k

Maintenance Costs

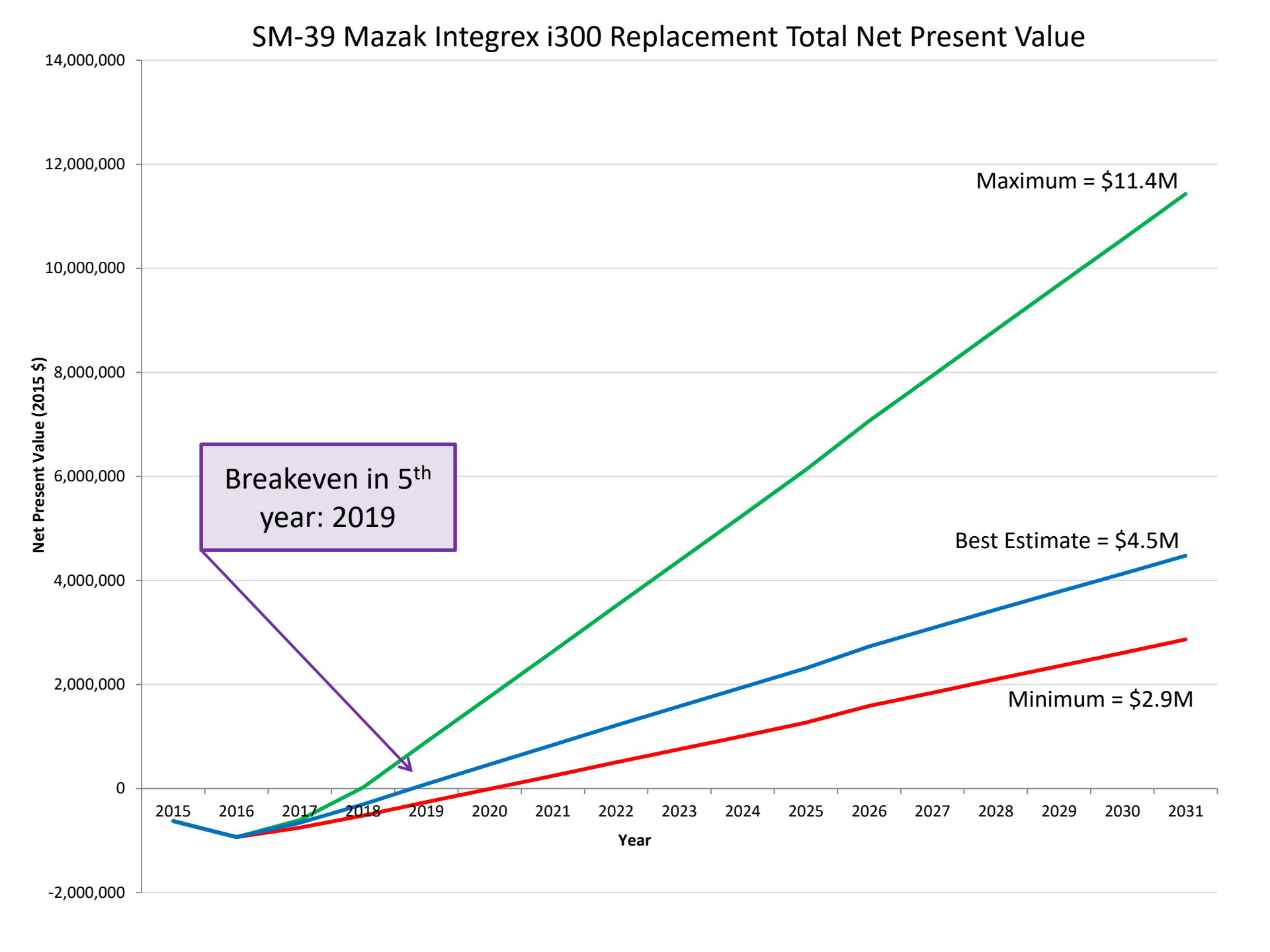
Preventative:	$23k/y
Corrective (CM):	see below

Productivity

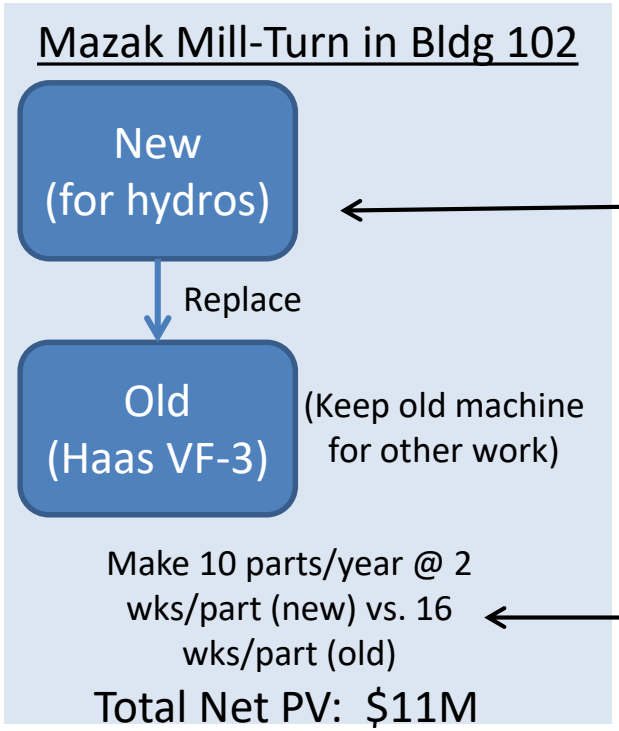
CM, Old Mazak	Cost
Every year:	$34k
Every 3 years:	$43k
Every 5 years:	$77k
Every 10 years:	$146k
Every 15 years:	$85k

→

CM, New Mazak	Cost
None	0
None	0
Every 5 years:	$43k
None	0
None	0


SM-39 Mazak Integrex i300 Replacement Total Net Present Value
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
-2,000,000
Net Present Value (2015 $)
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
Year
Maximum = $11.4M
Best Estimate = $4.5M
Minimum = $2.9M
Breakeven in 5th year: 2019

New Mazak in Bldg 102



One-Time Costs

Equipment:	$550k
Procurement:	$76k
Facility Prep:	$160k
Installation:	$55k
Training:	$22k
Qualification:	$52k

Maintenance Costs

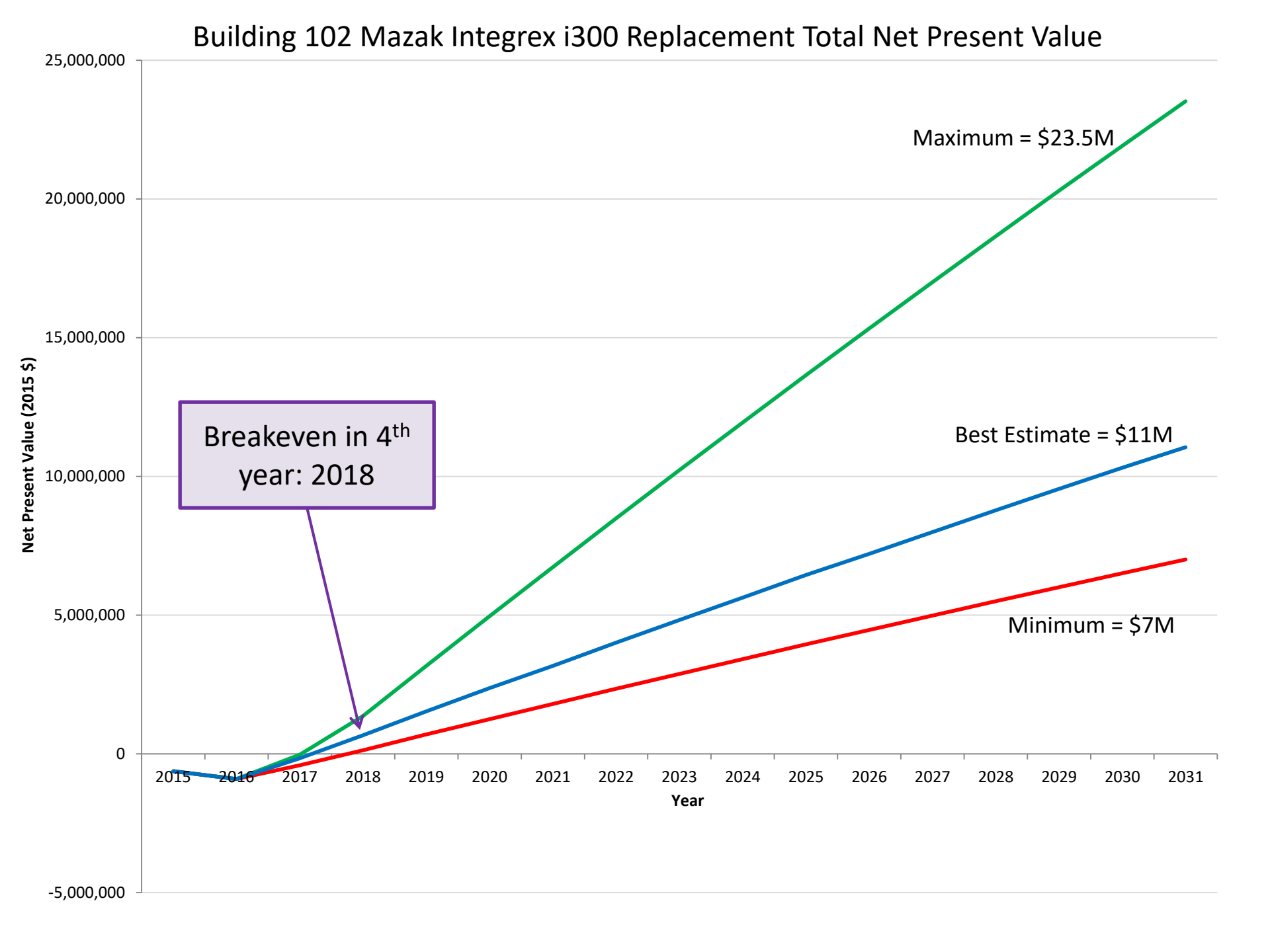
Preventative:	$23k/y (new) vs. $68k/y (old)
Corrective (CM):	see below

Productivity

CM, Old Haas	Cost
Every year:	$77k
Every 3 and 5 years:	$85k
Every 15 years:	$94k

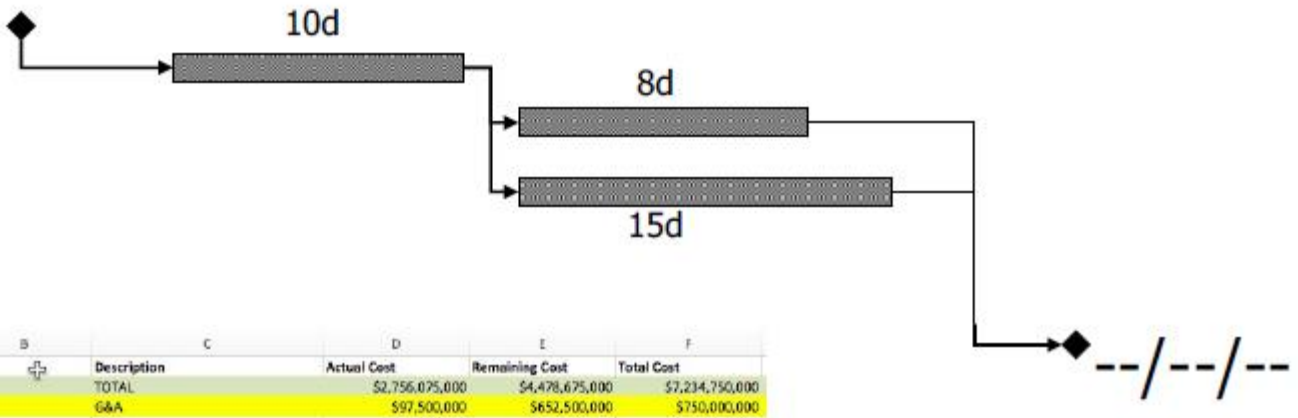
→

CM, New Mazak	Cost
None	0
None	0
Every 5 years:	$43k
None	0
None	0


Building 102 Mazak Integrex i300 Replacement Total Net Present Value
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
-5,000,000
Net Present Value (2015 $)
Maximum = $23.5M
Best Estimate = $11M
Minimum = $7M
Breakeven in 4th year: 2018
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
Year

Project Risk Management and Analysis

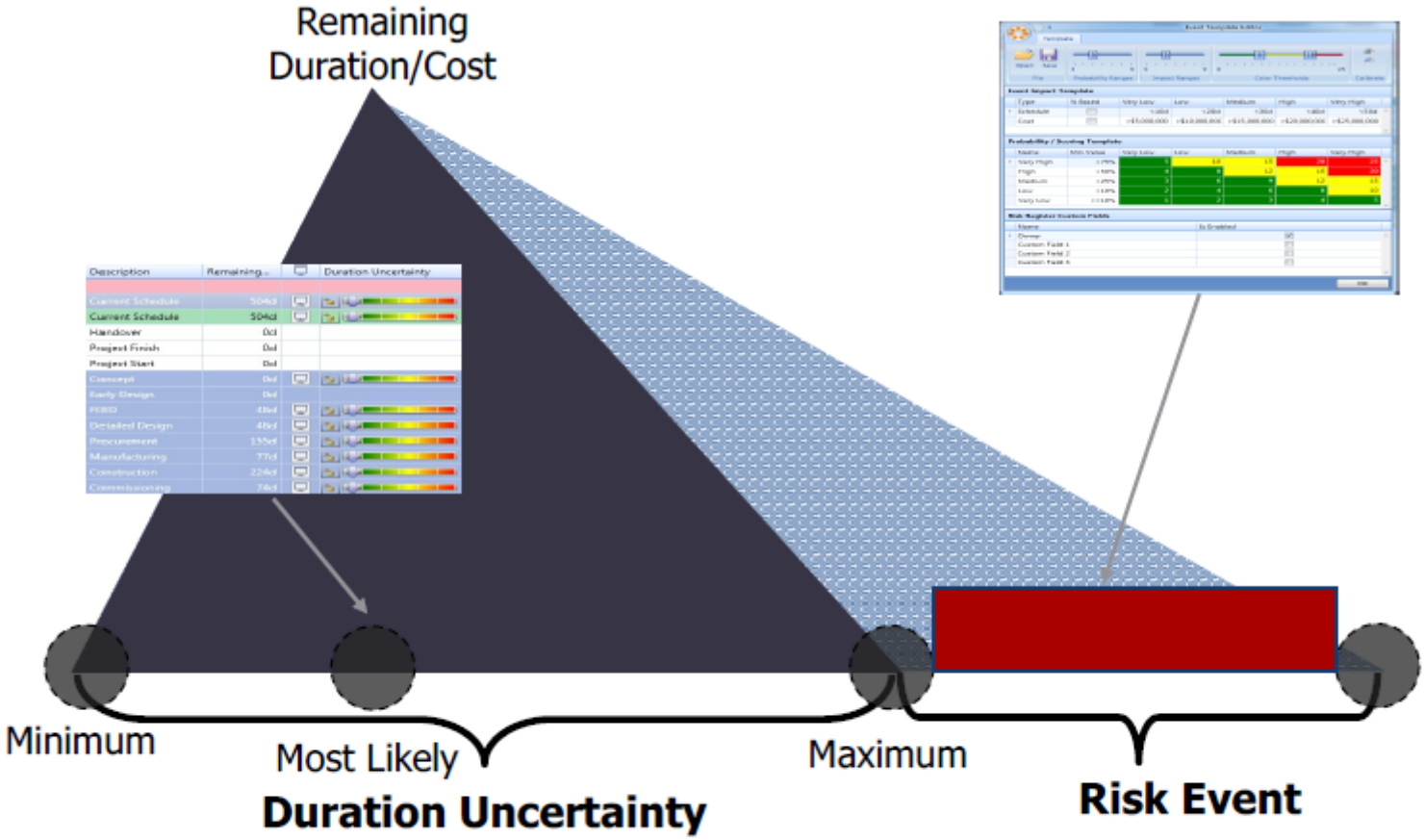
Example traditional schedule:



ID	WBS	Description	Actual Cost	Remaining Cost	Total Cost
10	1	TOTAL	$2,756,075,000	$4,478,675,000	$7,234,750,000
20	1.1	G&A	$97,500,000	$652,500,000	$750,000,000
30	1.1.1	G&A Manpower	$65,000,000	$435,000,000	$500,000,000
80	1.1.2	Business Travel and Expenses	$6,500,000	$43,500,000	$50,000,000
90	1.1.3	Legal	$6,500,000	$43,500,000	$50,000,000
100	1.1.4	External Studies	$13,000,000	$87,000,000	$100,000,000
110	1.1.5	JV Costs	$6,500,000	$43,500,000	$50,000,000
150	1.3	Drilling	$1,395,900,000	$1,142,100,000	$2,538,000,000
160	1.3.1	Phase I	$896,500,000	$733,500,000	$1,630,000,000
170	1.3.1.1	Rig rate & Site preparation	$302,500,000	$247,500,000	$550,000,000
180	1.3.1.2	Drilling Tangibles	$82,500,000	$67,500,000	$150,000,000
190	1.3.1.3	Completion Tangibles	$55,000,000	$45,000,000	$100,000,000

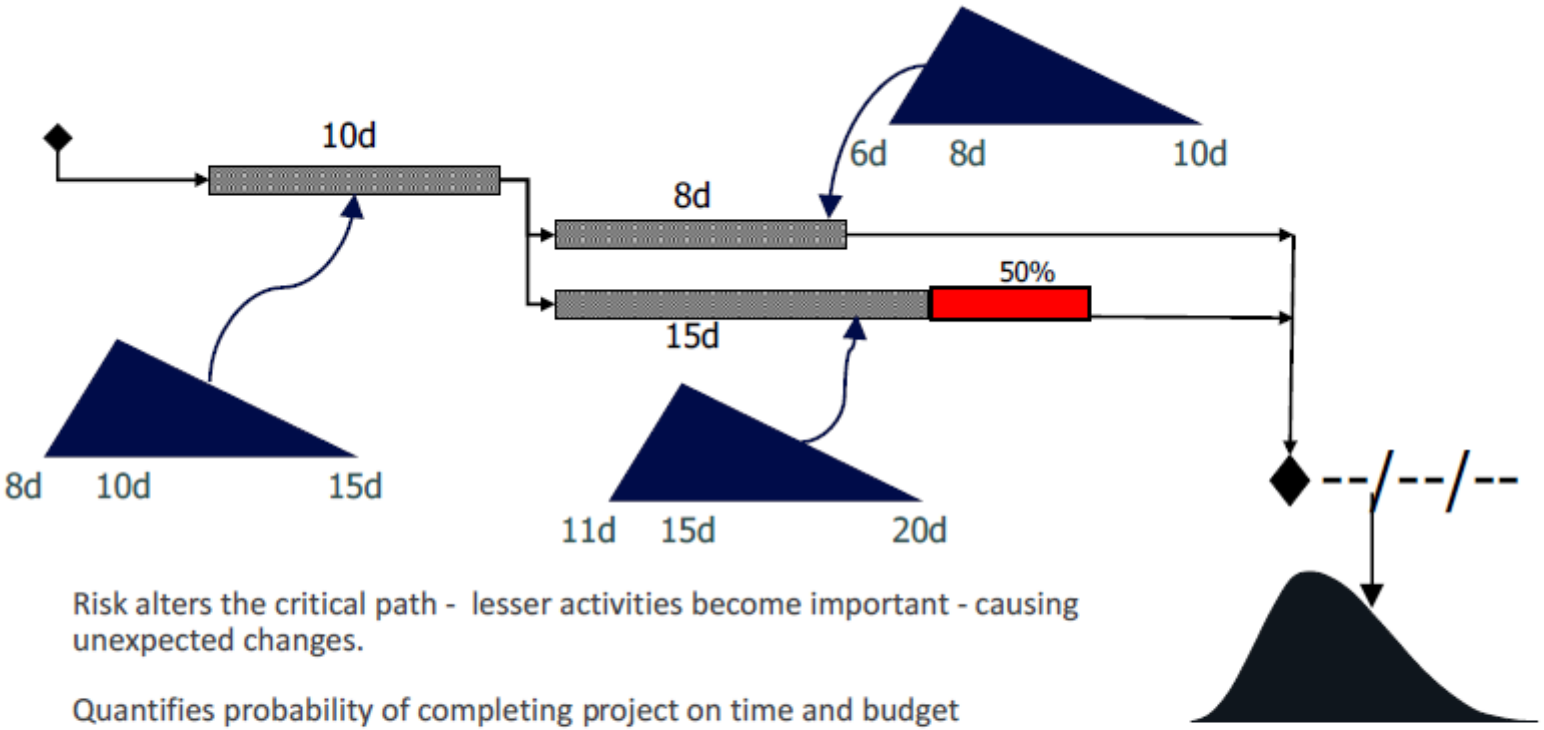
- ✓ Predicts single completion date and cost and specifies a critical path that is single and fixed.
- ✓ Uses single values for activity durations and costs
- ✓ Does not take uncertainty or discrete risk events into account

Activities can have both uncertainty and risk events



Duration/Cost Uncertainty + Risk Events = Total Risk Exposure

Schedule risk analysis models the uncertainty and risk quantitatively



Risk alters the critical path - lesser activities become important - causing unexpected changes.

Quantifies probability of completing project on time and budget

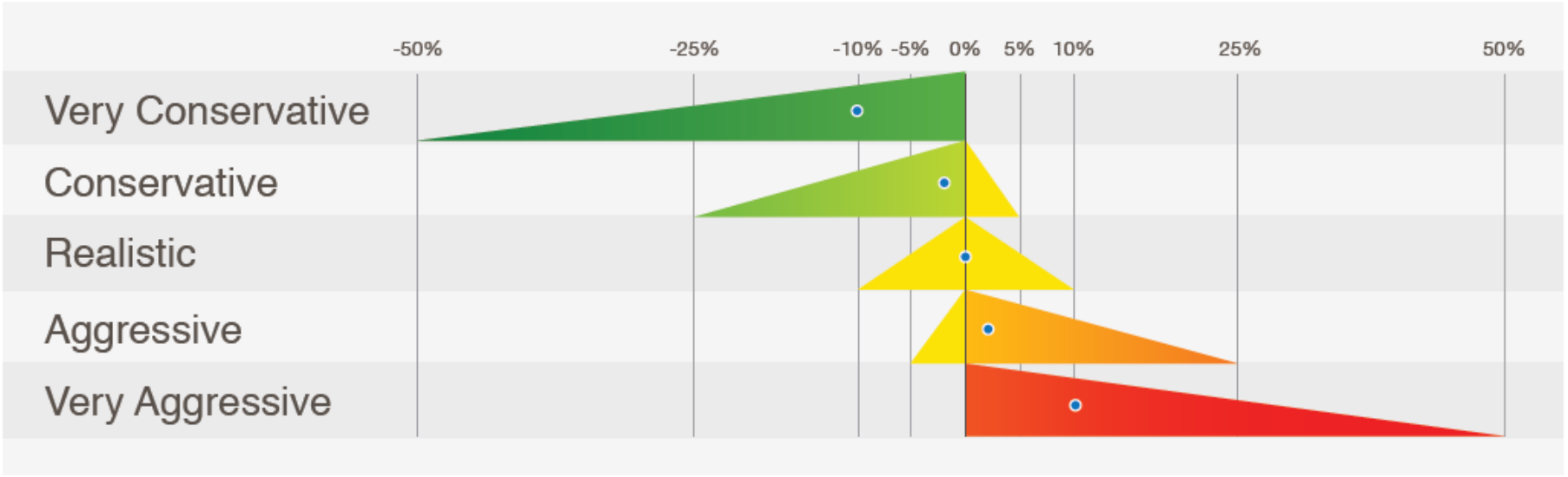
Takes both **uncertainty** and **risk events** into account

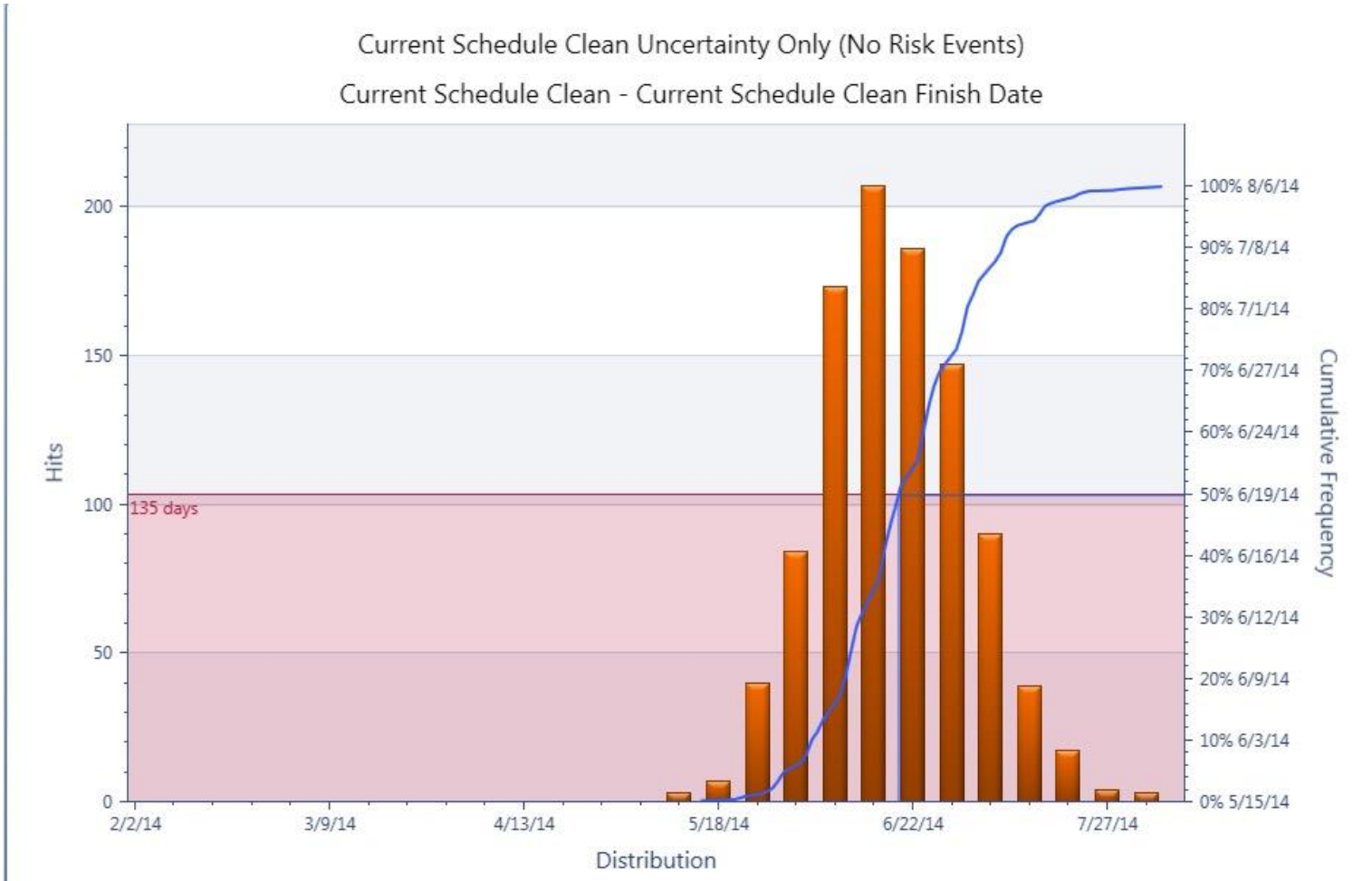
Numerical Analysis Methodology

- Monte Carlo or Latin Hypercube
- All methods subject to schedule logic, constraints, input types

Example Schedule Risk Analysis
Step 1: Uncertainty Only

A	B	C	D	E	F
ID	WBS	Description	Actual Cost	Remaining Cost	Total Cost
10	1	TOTAL	$2,756,075,000	$4,478,675,000	$7,234,750,000
20	1.1	G&A	$97,500,000	$652,500,000	$750,000,000
30	1.1.1	G&A Manpower	$65,000,000	$435,000,000	$500,000,000
80	1.1.2	Business Travel and Expenses	$6,500,000	$43,500,000	$50,000,000
90	1.1.3	Legal	$6,500,000	$43,500,000	$50,000,000
100	1.1.4	External Studies	$13,000,000	$87,000,000	$100,000,000
110	1.1.5	JV Costs	$6,500,000	$43,500,000	$50,000,000
150	1.3	Drilling	$1,395,900,000	$1,142,100,000	$2,538,000,000
160	1.3.1	Phase I	$896,500,000	$733,500,000	$1,630,000,000
170	1.3.1.1	Rig rate & Site preparation	$302,500,000	$247,500,000	$550,000,000
180	1.3.1.2	Drilling Tangibles	$82,500,000	$67,500,000	$150,000,000
190	1.3.1.3	Completion Tangibles	$55,000,000	$45,000,000	$100,000,000
200	1.3.1.4	Drilling Services	$110,000,000	$90,000,000	$200,000,000





Metric	Value
Deterministic - 0 %	2/4/14
Mean (P53)	6/21/14
P0 - Best Case	5/15/14
P50	6/19/14
P50 Contingency	135 days
P100 - Worst Case	8/6/14
Range	83 days
Risk Range Factor	12 %

Step 2: Define Risks and Estimate Probabilities and Impacts

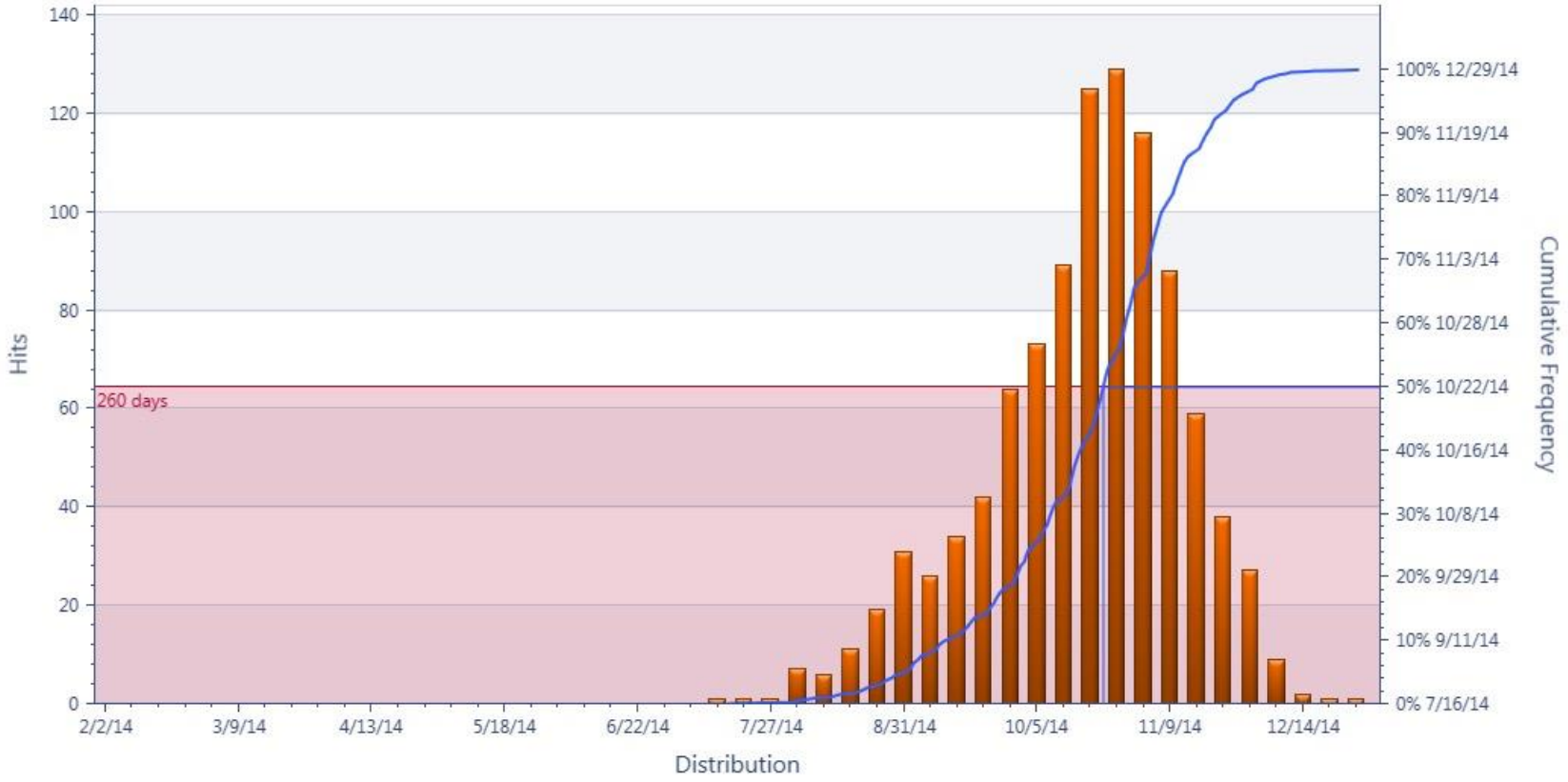
Probability / Scoring Template

Name	Min Value	Very Low	Low	Medium	High	Very High
Very High	>75 %	5	10	15	20	25
High	>50 %	4	8	12	16	20
Medium	>25 %	3	6	9	12	15
Low	>10 %	2	4	6	8	10
Very Low	<=10 %	1	2	3	4	5

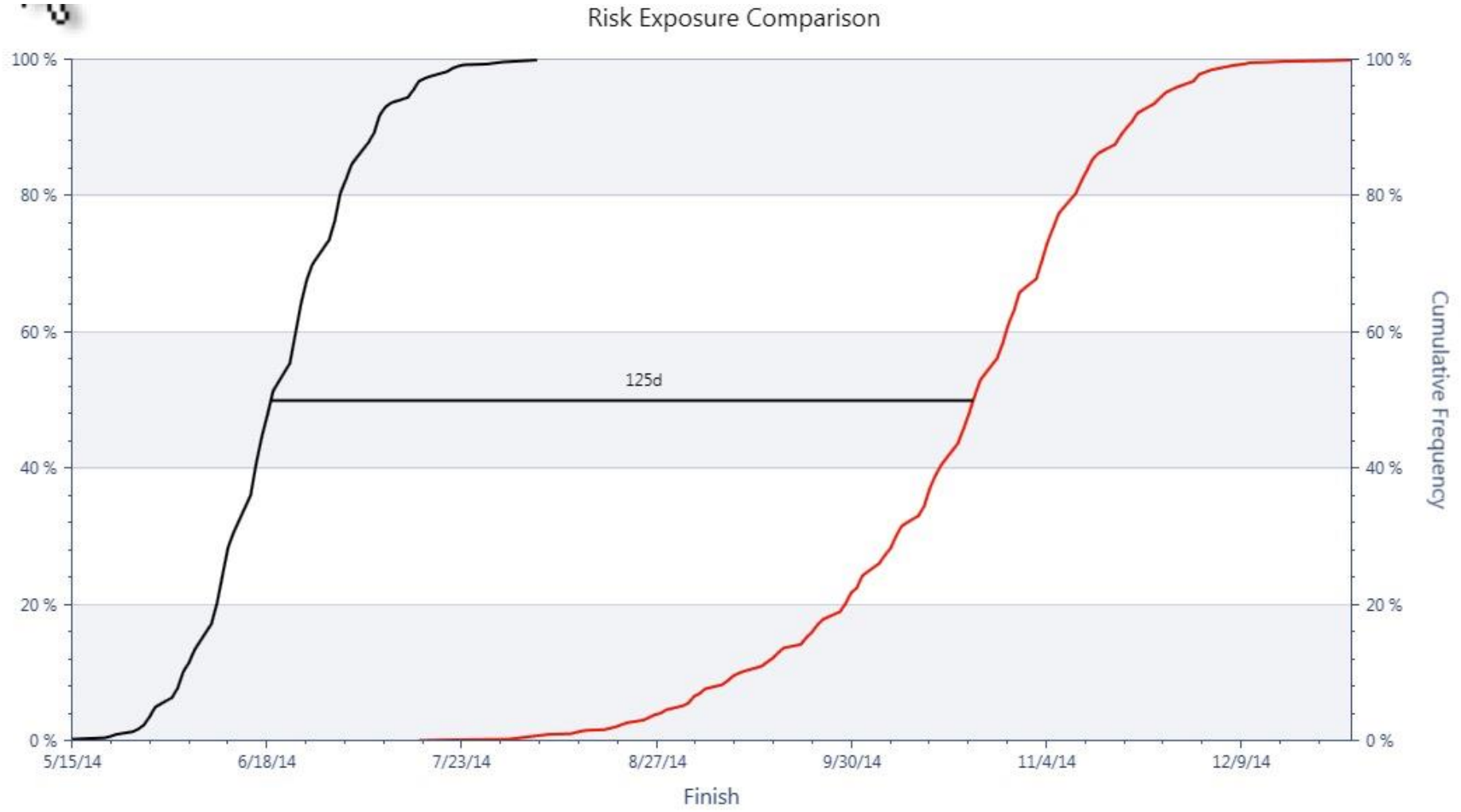
Risk					Current				
Enabled	Absolu...	ID	Type	Name	Probability	Schedule	Cost	Score	E
☑	☐	R1		Risk of delay post transportation...	Very High	Very High	Very High	25	
☑	☐	R2		Risk of customs delays	High	High	High	16	
☑	☐	R3		Risk of insufficient in country skille...	Very High	Low	Very High	25	
☑	☐	R4		Risk of insufficient SURF contracto...	Low	High	Very High	10	
☑	☐	R5		Risk of pirates during FPSO sail fro...	High	High	Medium	16	
☑	☐	R6		Risk of poor quality materials bein...	Medium	Medium	Low	9	
☑	☐	R8		Risk of damage to key equipment...	Low	Low	Medium	6	
☑	☐	R9		Risk of delay due to fab yard cons...	Very High	Very High	High	25	
☑	☐	R10		Risk of delay due to heavy lift vess...	Low	Very High	Very High	10	
☑	☐	R11		Risk of lack of labor availability of...	Medium	Medium	High	12	
☑	☐	R34		Risk of actual required resources e...	Very High	High	Medium	20	
☑	☐	R35		Risk of major mechanical equipme...	Medium	High	Low	12	
☑	☐	R36		Riks of theft of materials (especiall...	High	Very High	High	20	
☑	☐	R37		Risk of major dredging equipment...	Very High	Very High	High	25	
☑	☐	R38		Risk of change in law impacting c...	High	Very High	Very High	20	
☑	☐	R40		Risk of review of safety report res...	Low	Medium	Medium	6	
☑	☐	R41		Risk of delay in approvals of visas	High	Low	Very High	20	
☑	☐	R42		Risk of inability to hire craft to mai...	Very High	High	Very High	25	
☑	☐	R44		Risk of Governmental agency dire...	Very High	Medium	Low	15	
☑	☐	R45		Risk of delays in releasing equipm...	Low	Very High	High	10	
☑		R7		Hurricane Window	Negligible	Negligible	Negligible		
☑		R12		Winter Weather Interruption	Negligible	Negligible	Negligible		

Current Schedule Clean Uncertainty and Risk Events (No Mitigation)

Current Schedule Clean - Current Schedule Clean Finish Date

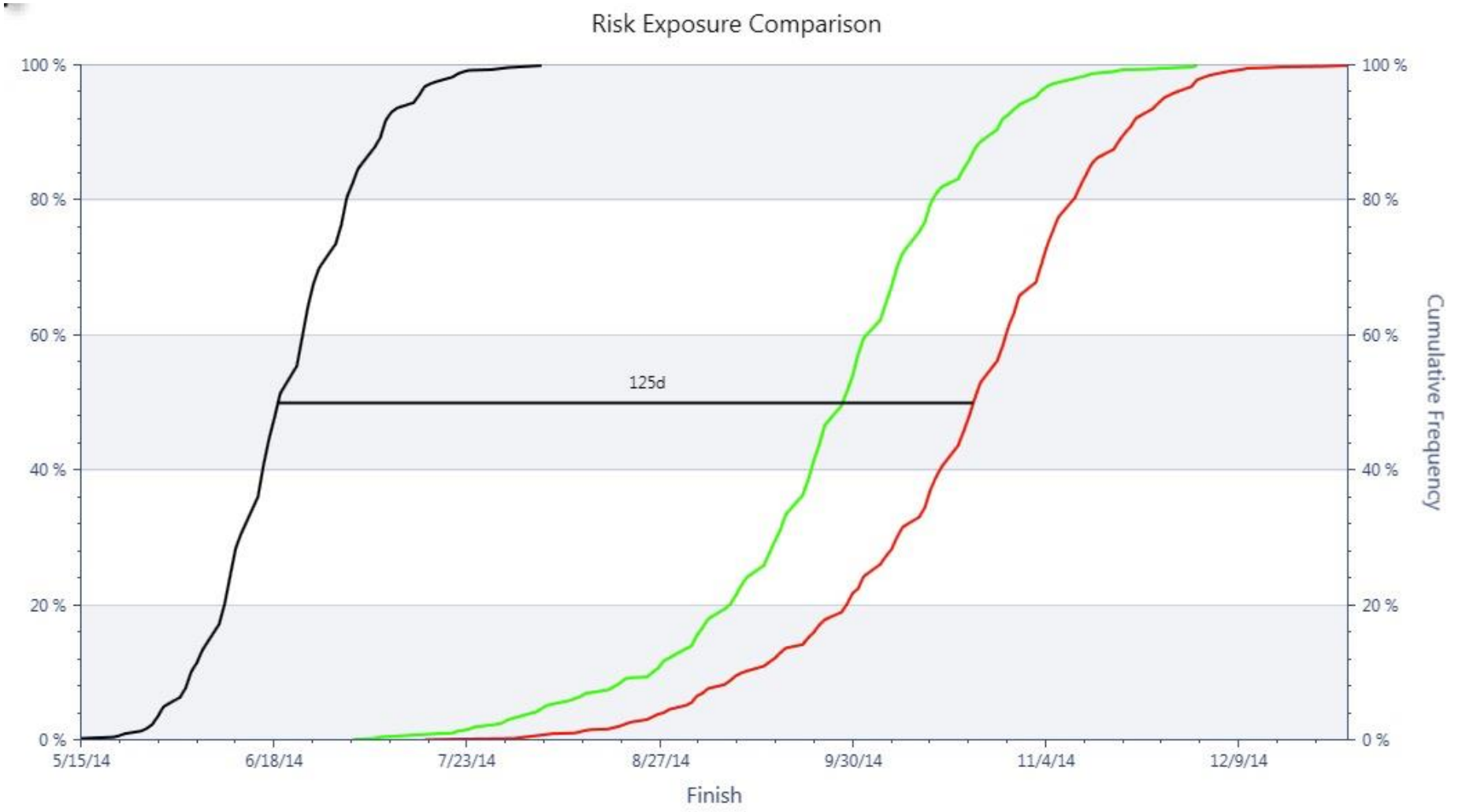


Metric	Value
Deterministic - 0 %	2/4/14
Mean (P44)	10/20/14
P0 - Best Case	7/16/14
P50	10/22/14
P50 Contingency	260 days
P100 - Worst Case	12/29/14
Range	166 days
Risk Range Factor	24 %



Curves | Variances

Visible	Color	Name	Deterministic Value	R...
☑	Black	Current Schedule Clean |Uncertainty Only	2/4/14	☒
☑	Red	Current Schedule Clean | Uncertainty + Risk Events	2/4/14	☒



Curves | Variances

Visible	Color	Name	Deterministic Value	R...
☑	Black	Current Schedule Clean |Uncertainty Only	2/4/14	☒
☑	Red	Current Schedule Clean | Uncertainty + Risk Events	2/4/14	☒
☑	#FF00FF00	Current Schedule Clean | Uncertainty + Risk Events + Recommended Mitigation	2/4/14	☒


JP II Statue
2015-05-18 21:38:19